

# Regional Water Cycle Consistency in Atmospheric Reanalysis

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# Regional water transport from reanalyses

- Robertson et al. (2014) showed significant **consistency** between reanalyses ocean **atmospheric divergence** and **global LDAS P-E**
  - Does this result extend to continental regions?
- Assimilation of state fields observations (water vapor and winds) changes the states in a non-physical way (can be a source/sink).
- How to best use reanalysis transports with water cycle observations to characterize **regional** water balance? **Or**
  - What information can help characterize transport uncertainties?

## Consistency of Estimated Global Water Cycle Variations over the Satellite Era

F. R. ROBERTSON,\* M. G. BOSILOVICH,<sup>+</sup> J. B. ROBERTS,\* R. H. REICHLE,<sup>+</sup> R. ADLER,<sup>#</sup> L. RICCIARDULLI,<sup>@</sup> W. BERG,<sup>&</sup> AND G. J. HUFFMAN\*\*

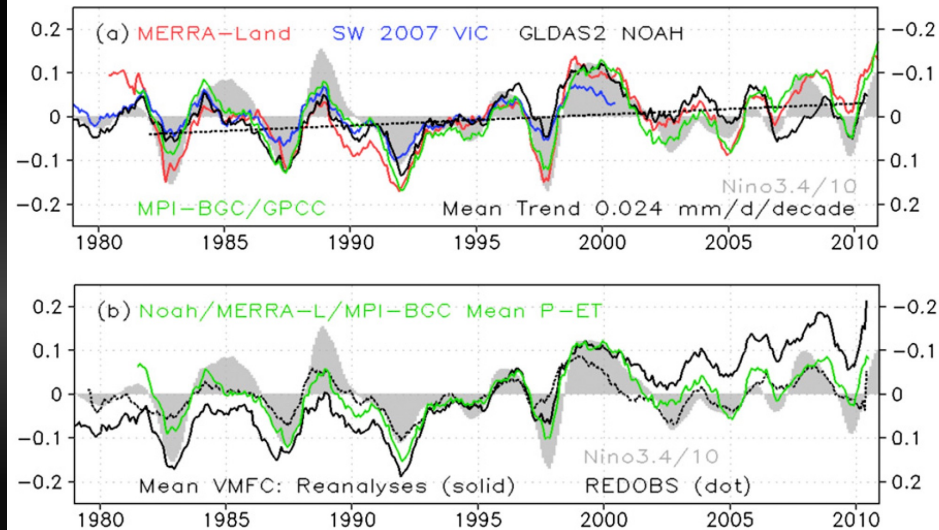


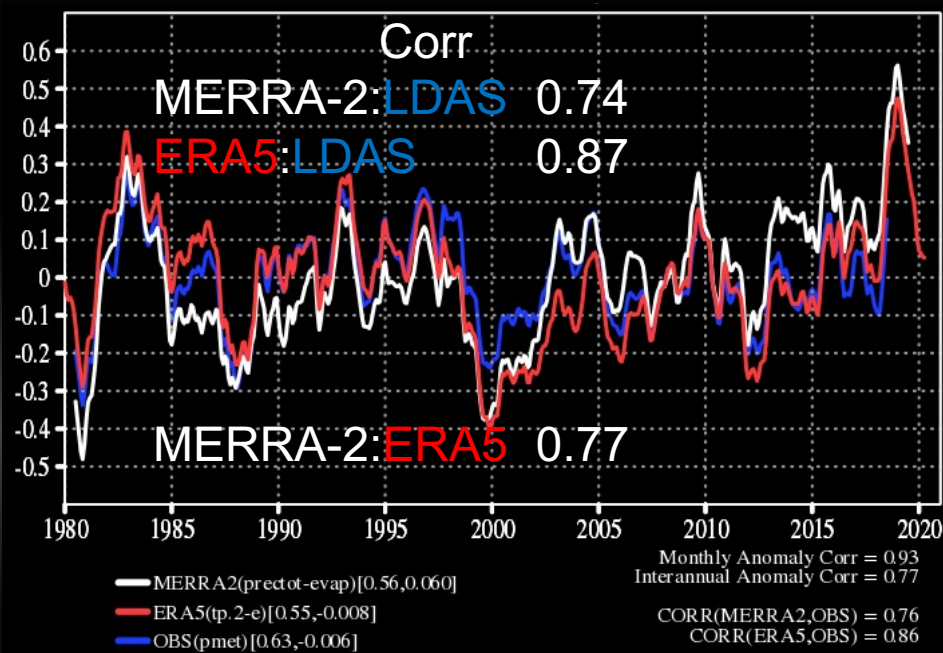
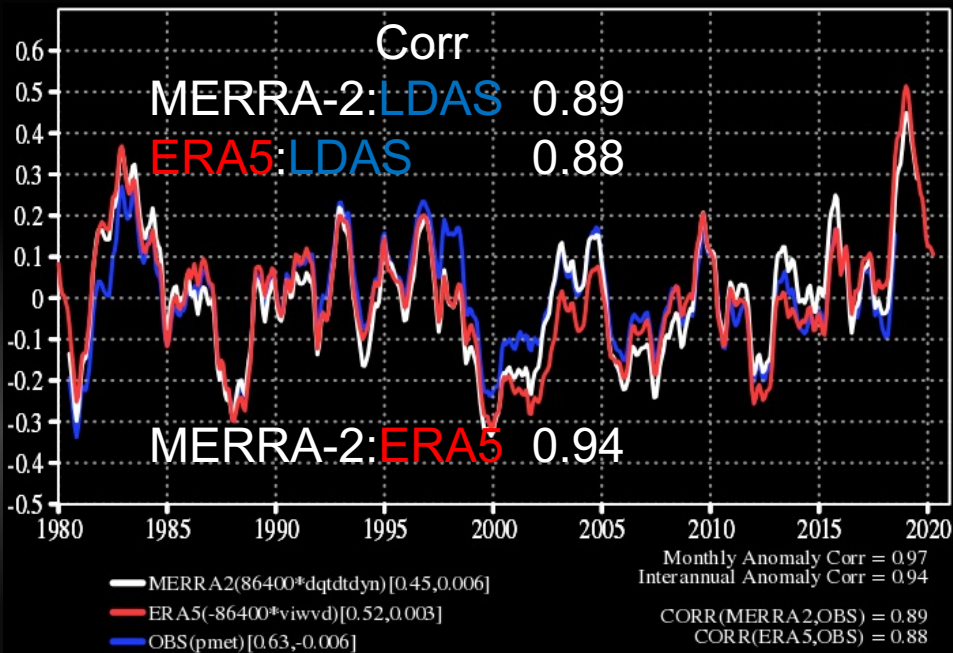
FIG. 7. (a) Global land (60°N/S)  $P - ET$  anomalies for each of the LSMs. The trend was calculated from the average of the monthly reanalysis/model anomalies before smoothing was applied. Note that the Niño-3.4 index (shaded gray) is plotted using the reversed scale on the right. (b) Global land (60°N/S) ensemble mean LSM  $P - ET$ , reanalysis VMFC, and REDOBS VMFC ( $\text{mm day}^{-1}$ ). All units are  $\text{mm day}^{-1}$ . A 13-month running smoother is applied.

J. Clim., 2014

-DIV

CONUS

P-E



\*Anomalies

LDAS derived from an ensemble of Global Hydrology Models ([AGU FM21 GC55K-0549](#))

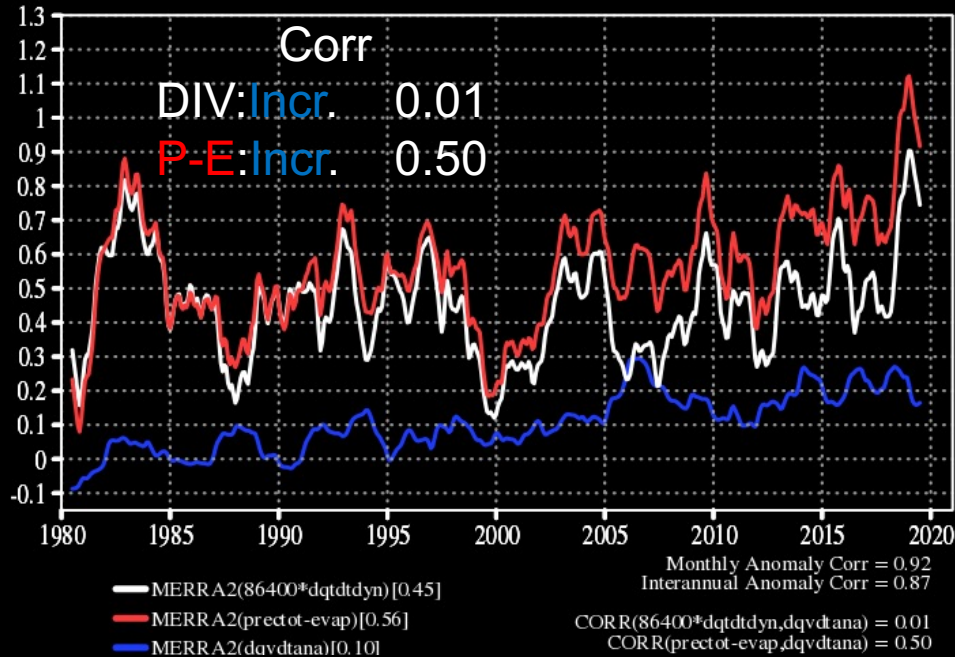
Reanalysis DIV correlates well with LDAS P-E, some spread in mean values

MERRA-2 precipitation trend affects the P-E

$$\left. \frac{\partial Q}{\partial t} \right|_T = -\nabla \cdot (qV) + E - P + \left. \frac{\partial Q}{\partial t} \right|_{ANA}$$

## Balance

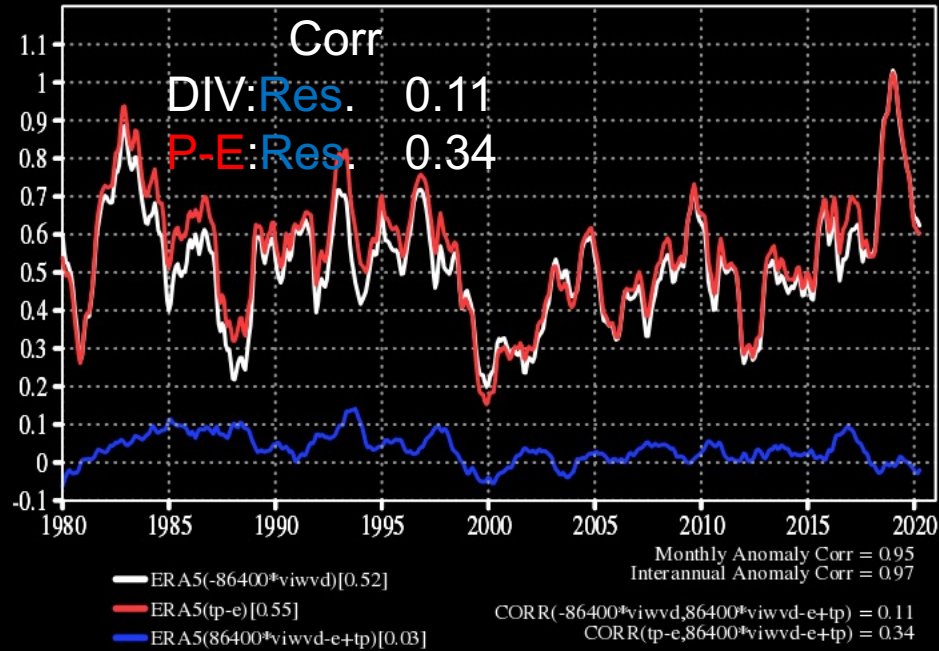
## MERRA-2



DIV

P-E

## ERA5

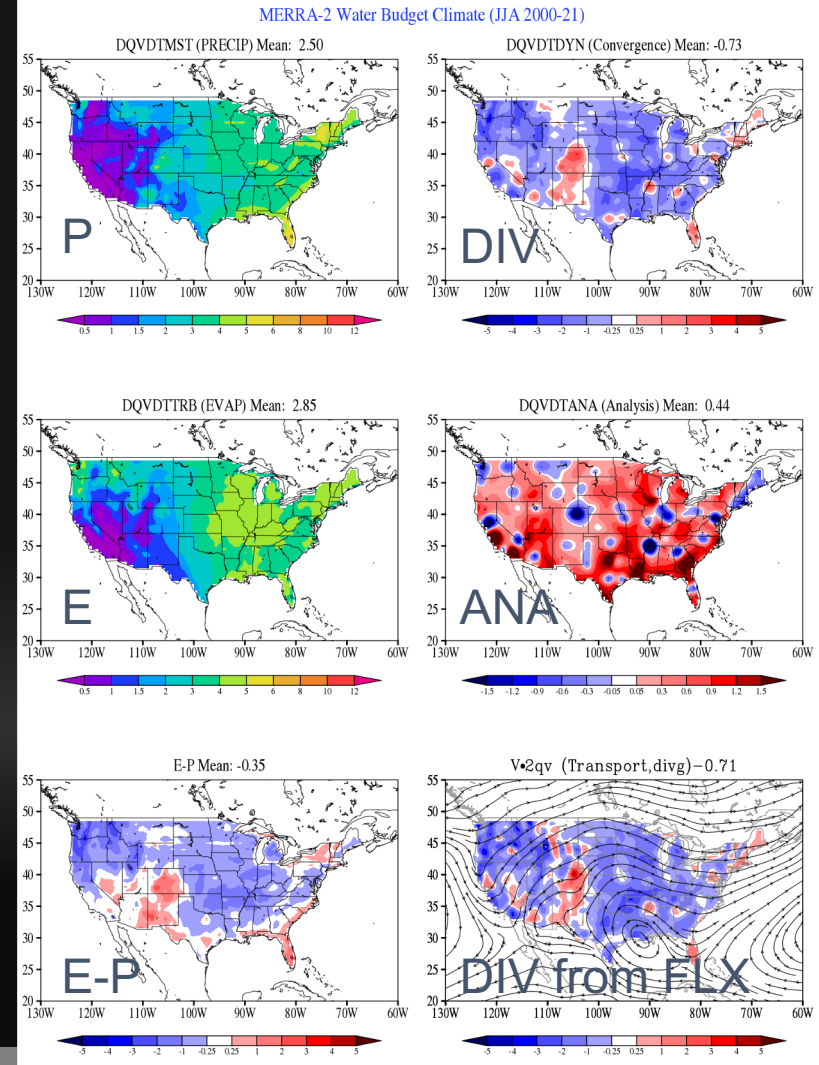


Incr./Res.



# JJA Water Cycle Terms; 2000-2021 Mean

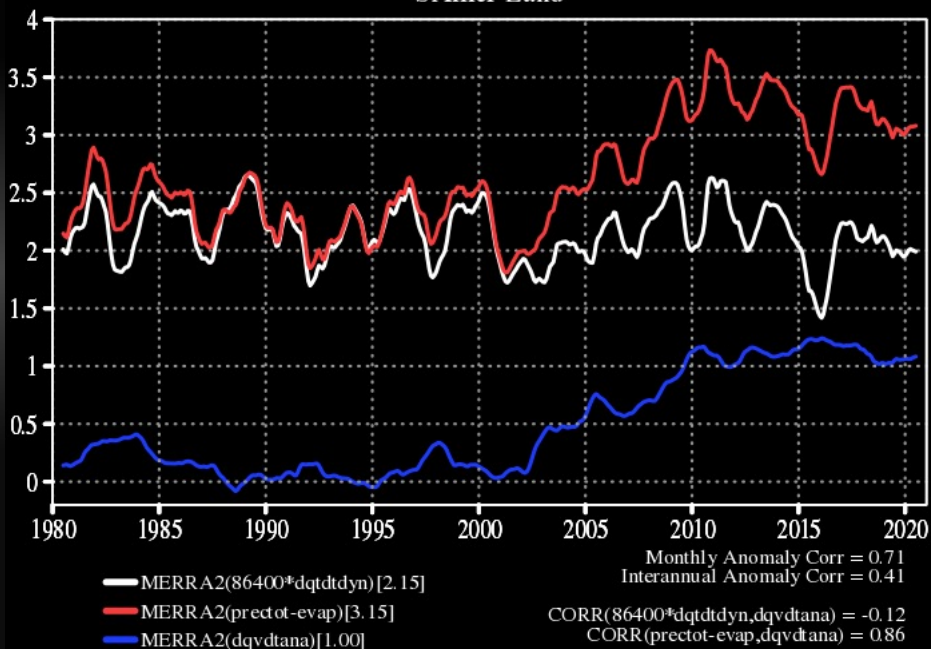
- General pattern of DIV and E-P match
- ANA shows a moistening pattern with pockets of drying around the radiosondes - A feature we have known about, except, it appears to have some reflection in the DIV term, which leads to correlation
  - CONUS evaluation, **after AIRS**, mainly summer
  - 06, 18 UTC - Analysis tried to moisten CONUS
  - 00, 12 UTC - Dries the air, but has a limited radius of influence
  - A **consistent spatial pattern** of the increments in this struggle emerges, and is reflected in the divergence field
- Divergence post processed from moisture transport vector components still demonstrates the anomalous pattern (lower left panel)



# South America Balance

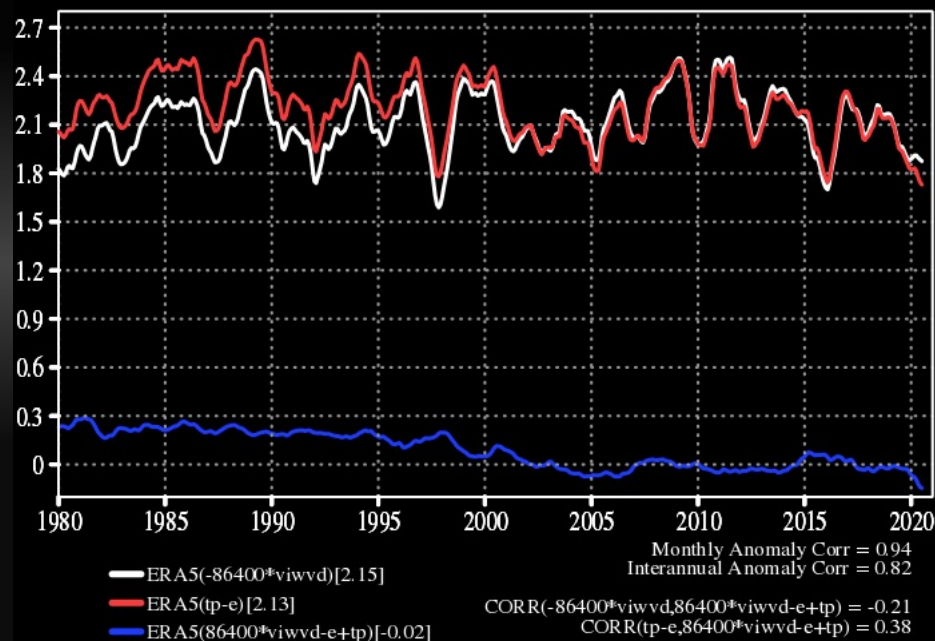
## MERRA-2

SAmer-Land



## ERA5

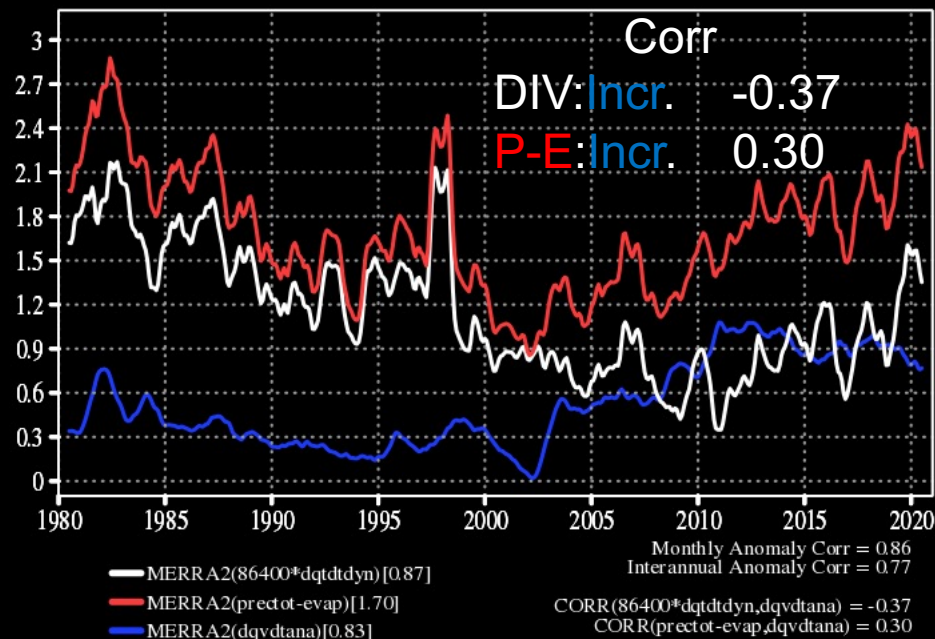
SAmer-Land



# Central Africa Balance

## MERRA-2

Central Africa



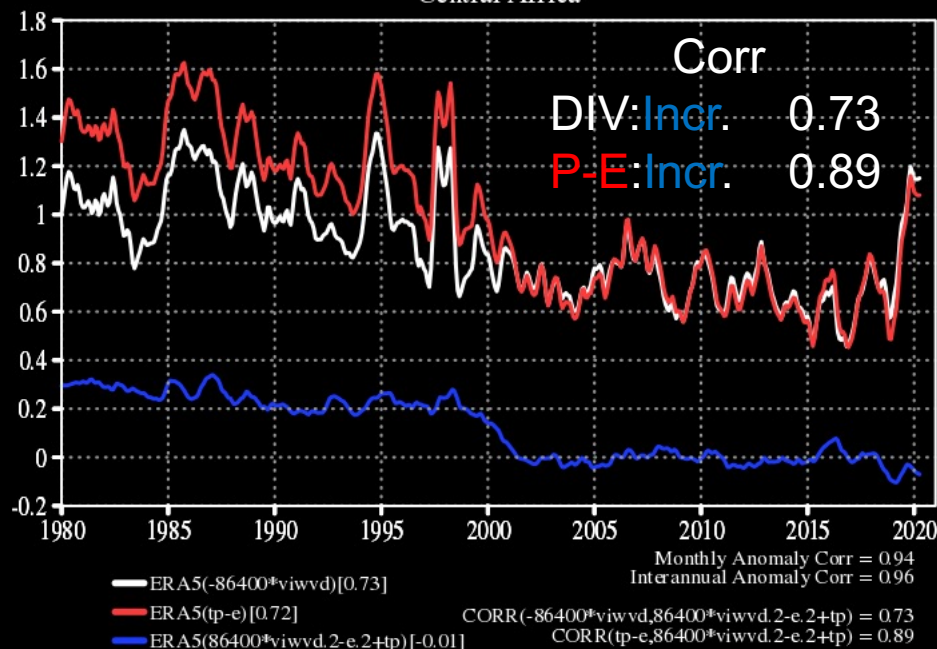
DIV

P-E

Incr./Res.

## ERA5

Central Africa



## Summary

- Regional water vapor transport from reanalyses do correspond well to global hydrology models P-E
  - ERA5 has an edge over MERRA-2
  - High correlations between the two exist in well observed regions
- Uncertainty is a function of space and time, generally relating to the volume of observations in the region
  - Central Africa transport and water cycle uncertainty is high in both reanalyses, and apparent in means, variability and trends (and particularly noticeable in the precipitation)
- See [Robertson et al.](#) poster this session for GHM discussion